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The tube and the egg cell cavity were clearly seen. They were light and bright, doubtless due to the refractive quality of the cytoplasm.

May 13th, an archegonium was observed in which a drop of dark fluid was passing slowly down the tube. It reached the egg cell. The egg cell changed in appearance, dividing, then uniting and finishing for the time of observation in a bright cell with a small dark spot on the upper side. This may have been the downward passage of an antherozoid. It was not clear enough for a positive statement, but it suggests something to be looked for about the middle of May.

June 14th, in a tuft examined one archegonium had a sheath around its base. The cover glass was pressed and the embryo sporophyte came out at the base. The other four were nearly as tall but had no sheaths.

July 14th, the Catharinea sporophytes were about one-half inch above the leaves. They looked like slender green stems. One week later the capsules began to show, and by August 1st the calyptras were seen.

October 1st, the sporophytes were of full height but the capsules were not completely filled out. December 1st, these seemed full grown but there was no suggestion of their capsules opening.

Bringing forward the first observation of the year it may be safe to conclude that these capsules will discharge their spores next March and April.

This Catharinea therefore developes more rapidly than the Hair-cap. For Catharinea the time from the maturity of the antheridia and archegonia and their contents, to the maturity of the sporophytes is about eleven months, while for the Hair-cap it is seventeen months.

Botanical Laboratory, University of Vermont, Jan. 18, 1905.

LICHENOLOGY FOR BEGINNERS.

Frederick Leroy Sargent.

In popular language we hear lichens usually spoken of as "mosses," a name which, unfortunately, belongs by right to little leafy plants very different from lichens, and has, moreover, been applied to so many other kinds as to have become sadly indefinite. On the other hand, the name *lichen*—which was given to this group about two hundred years ago by the great botanist Tournefort—has the advantage of being used for these plants alone, and is therefore much to be preferred.

It is usually an easy matter to distinguish a lichen at sight. In the first place, the absence of anything like leaves regularly arranged upon a stem, at once separates them from the true mosses and higher plants. Then there is the peculiarity that, although a great variety of colors are exhibited, there is one—the bright green of foliage or grass—which, under ordinary circumstances, they never assume; and in this respect they differ from certain liverworts which in form they sometimes resemble. Although they often grow where there is moisture, lichens are not aquatic, and thus they differ from *Algae*, which, with few exceptions, grow only in the water. Finally, the fact that lichens are air-plants—*i. e.*, derive all their nourishment from the air—serves to separate them from fungi, which require for food either living animals or plants, or else their decomposing remains. In short, given a plant which is leafless, of some other color than grass-green, aerial, and dependent merely for mechanical support on the object to which it is attached, and we may be reasonably sure that our plant is a lichen. For final decision, in certain cases, a microscopical examination of the internal structure is necessary: but to this matter we shall return.

The extreme simplicity of their needs, and their indifference, for the most part, to cold, heat, drought, and other rigors of climate, make it possible for lichens to grow in a great variety of situations, which, but for them, would be scarcely occupied by vegetation at all. Wherever a tolerably permanent foothold is offered, with a chance of occasional moistening by dew or rain and an exposure to pure air and daylight, there one may expect to find lichens. They grow on rocks or stones, morter, brick, the bark of trees, perennial or evergreen leaves, old wood-work, stumps, and barren earth, and occasionally on bones, leather, or bits of crockery exposed to the weather. Their distribution over the face of the earth extends from sea-shore to the highest mountain-tops, and from the equator to as near the poles as man has been able to penetrate.

Although as a group they are distributed so much more widely than most other plants, and appear in general remarkably indifferent to their surroundings, nevertheless there are not a few species of lichens which show strong preferences for certain situations, and will thrive only under certain conditions. Thus, there are forms which occur only in northern regions or at high elevations, or which produce fruit only in such localities. Similarly, temperate and tropical regions have their peculiar forms, and likewise sub-Alpine and lower levels. Certain forms of lichens are found only on bark, certain others on rocks alone, and others, again, only on the earth. There is even with some species a preference for a particular sort of bark, or rock or soil. Thus, peaty, clayey, and sandy soils have different species growing on them; and calcareous, arenaceous, and granitoid rocks each have their own forms, which are rarely found elsewhere. Smooth-barked trees harbor lichens different from those on rough-barked trees. Even particular species of trees have their own peculiar forms of lichens, which seldom or never grow elsewhere. This is true of the cinchonas and certain other trees from which medicinal barks are obtained, and pharmacognocists have taken advantage of this fact to aid them in distinguishing the different varieties of bark imported.

The amount of moisture to be obtained and the degree of exposure to daylight are also important factors in deciding the dwelling place of many lichens. It is a fact well known to woodsmen that lichens in this part of the world are apt to grow most luxuriantly on the northern or northwestern side of tree trunks. This circumstance is often helpful in finding one's way through a forest. The reason why lichens choose one side by preference appears to be that, being less exposed to the direct rays of the sun, it remains moist somewhat longer after a rain; but exceptions abound.

Unlike most other plants, lichens are found in as perfect condition one season as another. Soon after a rain is a good time to gather them, as they are then more easily handled than when dry and brittle.

No very elaborate collecting outfit is necessary. A good sharp jack knife and something to contain the specimens are the most important requisites. For holding the different kinds as collected, the writer finds paper bags such as grocers use, particularly convenient. They take up so little room that a supply may be carried in the pocket and so be always handy for the collection of any good specimen that may turn up unexpectedly in one's walks. When one expects to gather more specimens than might be easily carried in one's pocket. a light basket is to be recommended. In order to obtain specimens which adhere firmly to rocks, bark and the like, it is necessary to detach portions of the substance upon which they grow. For this purpose it is well to have a cold chisel and a small sharp hatchet which may be used either as a hammer in connection with the chisel or to chop off slices of hard bark or wood. Only experience can teach the collector how to obtain good rock specimens, but a little practice will show how blows may be most effectively directed. After a fragment has been detached it is often possible to trim off superfluous material, and for obvious reasons it is best when possible to do this at the time. The specimen should always include enough of the margin of the lichen to show its character. To prevent the heavier specimens from injuring the more delicate ones, it is well to put the latter in a box by themselves. If one is collecting in a dry time a small sponge and some water is convenient to have for moistening such specimens as would be otherwise too brittle to be easily detached without injury.

While collecting, the conditions under which a given sort are growing, should be carefully noticed, and a record of this, together with the locality, should be made on the bag or wrapper which is to contain the specimen. For example such a note might read: "On trunk or branches of apple trees. Cambridge, Mass., March, '91." The date, however, is not so necessary in the case of lichens as with most other plants.

Whenever possible it is important to obtain specimens in fruit (the form of which will be described later). Certain species may never produce fruit in the student's locality, but in such cases their study is best pursued in the light of knowledge previously gained from perfect specimens of allied forms.

Some species have the fruit so small and inconspicuous as scarcely to be seen with the naked eye. It is well, therefore, to have at hand a pocket lens magnifying about ten to twenty diameters, to scrutinize such minute structures.

Soon after the specimens have been brought home is the best time to prepare for the herbarium such as need preparation. The slices of bark will curl unless dried under pressure. If they are already curled and dry, soaking in cold water will render them flexible, after which they may be put in press. Warm water should never be used to moisten lichens as it discolors them. Specimens which are shrubby or of considerable thickness may be flattened under light pressure between folds of a newspaper. With such species as grow in close contact with the earth, it is often desirable to preserve intact a thin layer of the soil, so as to hold the plant together. This is accomplished by a coating of mucilage applied to the underside while the earth is moist.

There are several methods in use among students of lichens, for preserving and arranging their specimens. Different circumstances and requirements make different ways preferable. A favorite way to keep the specimens is in pockets, which are made as follows: Fold a piece of paper (7 by 9 inches is a convenient size) so the under part shall project about three-quarters of an inch beyond the upper; fold the projecting part over the other to make the top of the pocket: turn the pocket over and fold back the right and left edges for about three-quarters of an inch, and it is finished. Such pockets, if of uniform size, may be arranged in a box or tray like the cards of a card catalogue. When thus used, writing the name of the species at the top of the pocket, facilitates reference. This method of keeping specimens affords a way of making a good working collection with small outlay of time and labor. If it is desired to incorporate the specimens in a general herbarium, the pockets may be attached to the regular species-sheets by means of small ribbon pins, or with a spot of glue at the back. The chief objection to using pockets is that the specimens are not displayed. To accomplish this, specimens are glued onto pieces of rather stiff paper of convenient size (room being allowed for labeling), and then these pieces of paper are pinned to the herbarium sheets. In thus mounting lichens which have a distinct under side it is important that the character of this as well as the upper side be exhibited. Keeping specimens in scrap-books is hardly to be recommended, unless for a very small collection, since this method does not facilitate a systematic arrangement and interpolation of additions.

Rock specimens which are too bulky to be incorporated with the others may be kept like minerals in trays or in a cabinet. An approved way for large collections is to have pasteboard boxes made of such a size as to go with the rest of the collection in the herbarium case.

All specimens should be labeled with the botanical name of the species, the locality, habitat, and date of collection (if desired) together with the name of the collector (if other than the owner).

Having collected as many as possible of the common species of the neighborhood and prepared them conveniently for examination, the student is in position to begin an examination of their form, structure and classification.

A good deal may be learned about them without other aid than the simple microscope already recommended: but for thorough study of lichens, a good compound microscope, magnifying three to four hundred diameters, is essential. We shall consider, however, at this time chiefly such features as involve in their study comparatively simple microscopical manipulations.

Cambridge, Mass.

(To be continued.)